



J. Pope

Pamphlet Case No. 20.

HALLEY'S COMET

WITH BRIEF NOTES ON

COMETS IN GENERAL.

BY

GEORGE F. CHAMBERS, F.R.A.S.

OF THE INNER TEMPLE, BARRISTER-AT-LAW,

AUTHOR OF

"A HANDBOOK OF ASTRONOMY," "A CONVERSATIONAL ENGLISH-FRENCH-GERMAN
DICTIONARY," "THE TOURIST'S POCKET-BOOK," AND OTHER WORKS.



THE GREAT COMET OF 1882. NAKED-EYE VIEW ON NOV. 14. (*B. J. Hopkins*)

OXFORD

AT THE CLARENDON PRESS

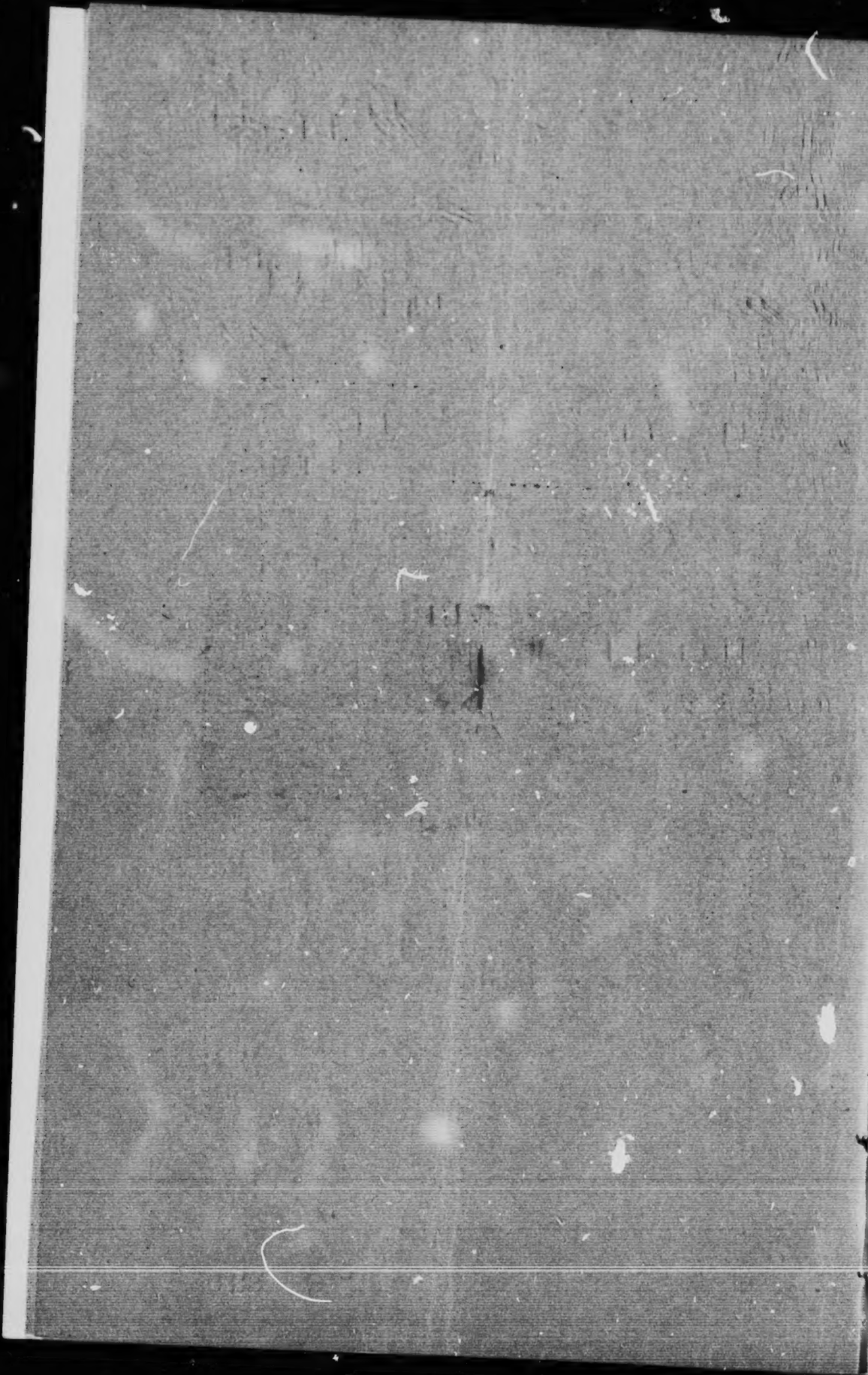
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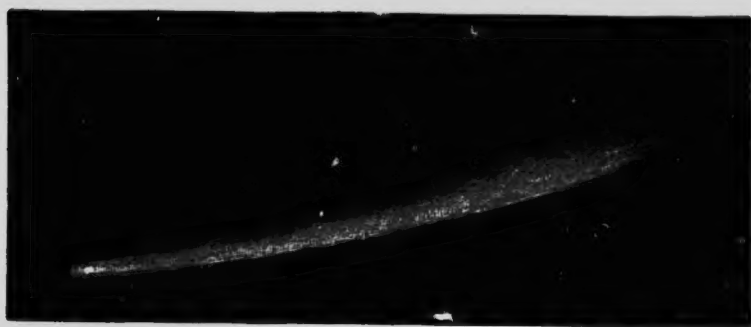
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ADVERTISEMENT.

THIS brochure, extracted almost *verbatim* from my *Story of the Comets*, is published in obedience to a suggestion that large numbers of people are interested just now in Comets, and would like to know something about Halley and his Comet and about Comets in general. The scope of the pamphlet is of course limited, and those who wish to study the subject in anything like detail must consult *The Story of the Comets*.

G. F. C.

LETHEN GRANGE,
SYDENHAM,
June, 1910.

CONTENTS.

PART I.—GENERAL REMARKS.

Popular appreciation of Comets and Eclipses and shooting stars.—Comets always objects of popular interest and sometimes of alarm.—Quotation from a writer of the 17th century.—Physical appearance of an ordinary Comet.—Comets without Tails more numerous than Comets with Tails.—General description of a Comet.—The Nucleus.—The Coma.—The Tail.—Small Comets usually circular in form or nearly so.—Path of a Comet.—Great diversity in the size and brilliancy of Comets.—Comets usually diminish in brilliancy at each return.—Halley's Comet, a case in point.—But this opinion has been questioned.—Holetschek's Inquiries.—Actual Dimensions of Comets.—The Colour of Comets Pages 7-18

PART II.—HALLEY'S COMET.

Halley's Comet by far the most interesting of the Periodic Comets.—Sir I. Newton and the Comet of 1680.—This Comet the first to which the theory of Gravitation was applied.—The Comet of 1682.—Description of it by various observers.—Luminous Sector seen by Hevelius.—Halley's application to it, and the Comets of 1531 and 1607, of Newton's mathematical researches.—He finds the elements of the three very similar, and suspects the three comets are really one.—With a probable period of 75 years.—Suspects the disturbing influence of planets on Comets.—Of Jupiter's influence especially.—Halley's final conclusion that the Comet would reappear in 1758.—Preparations by Clairaut and Lalande to receive it.—The Comet found by an amateur named Palitzsch near Dresden.—Some account of this man.—The Comet generally observed in Europe.—Trick played by De Lisle on Messier.—Return of the Comet in 1835.—Great preparations by Mathematicians to receive it.—These specially took into account planetary perturbations.—Predicted date of perihelion passage.—The Comet discovered by telescopes as expected.—Some particulars of the observations.—The past history of Halley's Comet traced back through many centuries.—Researches of Hind.—Confirmed in the main by Crommelin and Cowell.—Some quotations from old Chroniclers.—Observations by the Chinese of great value.—Halley's Comet in 1066.—Figured in the Bayeux Tapestry.—The Comet's various returns ascertained with certainty backwards to B.C. 250 ... 21-48

LIST OF ILLUSTRATIONS.

FIG.		PAGE
	The Great Comet of 1882	Title
1.	Halley's Comet, 1666. (<i>Bayeux Tapestry</i> .) Plate I.	6
2.	Telescopic Comet without a Nucleus	9
3.	Telescopic Comet with a Nucleus	9
4.	The Great Comet of 1843. Plate II.	11
5.	Donati's Comet, Oct 9, 1858. (<i>Pape</i> .) Plate III.	12
6.	Comparative sizes of the Earth, the Moon's orbit, and certain Comets, named. Plate IV.	15
7.	Comet III. 1862. Aug. 7. (<i>Challis</i> .) Plate V.	16
8.	Comet III. 1862. Aug. 18. (<i>Challis</i> .) "	16
9.	Comet III. 1862. Aug. 18. (<i>Challis</i> .) "	16
10.	Comet III. 1862. Aug. 19. (<i>Challis</i> .) "	16
11.	Comet III. 1862. Aug. 22. (<i>Challis</i> .) "	16
12.	Comet III. 1862. Aug. 29. (<i>Challis</i> .) "	16
13.	The Comet of 1847 (I), visible at noon on March 30. (<i>Hind</i> .)	17
14.	Portrait of Edmund Halley. Plate VI.	20
15.	Medal struck in Germany to allay the terror caused by the Comet of 1680	22
16.	Halley's Comet, Sept. 8, 1682 (N.S.), showing Luminous Sector. (<i>Drawn by Hevelius</i>)	24
17.	Plan of the Orbit of Halley's Comet compared with the orbits of certain Planets	27
18.	Halley's Comet, 1835-6. (<i>Drawn by C. P. Smyth</i> .) Plate VII.	33
19.	Halley's Comet, 1835, Oct. 11. (<i>Smyth</i> .)	37
20.	Halley's Comet, 684. (<i>From the Nuremberg Chronicle</i> .)	42

Fig. 1.



Plate I.

HALLEY'S COMET

AND

COMETS IN GENERAL.

PART I.

GENERAL REMARKS.

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QUITE irrespective of the remarkable growth of a taste for Astronomy which has marked the last quarter of a century, alike in Great Britain, Greater Britain, and North America, to say nothing of the Continent of Europe, there can be no doubt that comets^a have, and always have had, a great fascination for that student of science newly named "the man in the street". And next in order of interest certainly come Eclipses, Solar and Lunar, and Fire-balls and "Shooting Stars"; but these do not concern us now. It is not difficult to see why all these phenomena should be attractive to the popular mind: they are all sights which can be seen, and in a measure be studied, without professional teaching, and without much (or any) instrumental assistance.

^a From the Greek κομήτης, the "long-haired one". A woman's head, with long dishevelled tresses stream-

ing behind her, is often a not inapt representation of a comet with a head and tail.

In bygone times, before the invention of telescopes, it was only of course the larger comets which were or could be recorded: and as these frequently appeared with great suddenness in the nocturnal sky, usually in the first instance not far from the Sun, either after sunset or before sunrise, and often had attached to them tails of great size which were sometimes very bright, comets were well calculated in the earlier ages of the world to attract the attention of all and to excite the fear of many. It is the general testimony of History during many hundreds of years, one might even say during fully 2000 years, that comets were always considered to be peculiarly "ominous of the wrath of Heaven and as harbingers of wars and famines, of the dethronement of Monarchs and the dissolution of Empires". It is quite within the limits of truth to say that ideas such as these have not yet died out. One quotation of 17th-century origin will sufficiently summarise the opinions of many writers and thinkers. A poet of the epoch just named wrote thus:—

"A Blazing Star,
Threatens the World with Famine, Plague and War;
To Princes, death; to Kingdoms many crosses;
To all Estates, inevitable Losses;
To Herd-men, Rot; To Ploughmen, haplesse Seasons;
To Saylor, storms; to Cities, civil Treasons,"^b

Some further quotations of an analogous character are reserved for a subsequent chapter which deals with comets in history and poetry.^c

However little attention might have been paid by the Ancients to the ordinary displays of natural phenomena, certain it is that Comets and Total Eclipses of the Sun were not easily forgotten or lightly ignored: hence it is that the aspects of many remarkable comets seen in olden times have been handed down to us, often in language of circumstantial minuteness, and still more often in language of grotesque extravagance. The Chinese hold the palm under this head of literary style.

^b Du Bartas, *His Divine Weekes and Workes*, trans. J. Sylvester, 1621, p. 33.
^c See Chap. XIV of *The Story of the Comets*.

The physical difference between different comets is a matter very little appreciated or understood by people in general. With such, every thought is concentrated on the comet's tail, if it has one; or if it has not a tail, then the verdict is "no comet". Yet the facts of the case are that the comets with tails are, and always have been, considerably outnumbered by the comets without tails. An explanation of the popular view is to be found in the fact that the tailed comets are very frequently visible to the naked eye, whilst the tailless comets may be said to be never so visible.

An ordinary comet when first discovered by means of a telescope either consists of, or sooner or later develops, three parts. In the latter case the developement takes place some-

Fig. 2.



TELESCOPIC COMET
WITHOUT A NUCLEUS.

Fig. 3.



TELESCOPIC COMET
WITH A NUCLEUS.

what in the following manner: the telescope reveals a faintly luminous speck; its size increases gradually, and after some little time a *nucleus* appears. This word indicates that a portion of the comet is more condensed in its light than the rest. Both the size and the brilliancy of the object progressively increase; the cloud-like mass around the nucleus (called the *coma*^d) becomes less symmetrical, and this loss of symmetry, when it occurs, betokens the early developement of a *tail*. Nucleus and coma taken together are generally spoken of as the *head* of the comet. When a tail has become manifest it will be found to be brighter near the head than at the tip, and often brighter on one side than on the other.

^d Latin for "hair".

"Tip" as applied to the tail of a comet is generally little more than a figure of speech, because it is, as a rule, impossible to say what is the tip, that is, to say where the tail comes to an end. Occasionally the tail increases to a length, it may be, of 10 or 20 degrees of arc or more. In the case of comets of great size and brilliancy this tail sometimes spreads across a large portion of the heavens; sometimes there are more tails than one. An ordinary tail presents the appearance of a stream of milky-white light which is always fainter and usually broader the further from the head that one examines it. Occasionally the broadening of the tail towards its extremity becomes a very marked feature.

The nucleus of a small comet is generally circular, as indeed is the whole comet, but a nucleus is sometimes oval, and, in very rare cases, may present a radiated appearance. The nucleus, if visible to the naked eye (the comet itself being a small one), generally looks like, and may easily be mistaken for, a star or a planet, the coma not being visible until a telescope is brought to bear on the comet. But in a telescope such a comet will show as a point of light surrounded by a fog of light. Sometimes, of course, the foggy appearance may reveal itself even to the naked eye if the comet as a whole is sufficiently luminous. Arago remarked that the nucleus is generally eccentrically placed in the head, lying towards the margin nearest the Sun. I do not, however, think that this can be considered an established law applicable to the majority of the small comets; and under any circumstances it would seem to betoken the forthcoming appearance of something of the nature of a tail. Sometimes a comet will have 2 or more nuclei or bright centres of light, but *one* is the normal number.

The newly found comet approaches the Sun in a curvilinear path which frequently differs but little from a straight line. It generally crosses that part of the heavens in which the Sun is situated so near the Sun as to be lost in its rays, but it emerges again on the other side frequently with increased brilliancy and increased length of tail. The phenomena of disappearance are then not unlike those which marked the



THE GREAT COMET OF 1843. March 17.
AS SEEN FROM BLACKHEATH, KENT.



DONATI'S COMET: OCTOBER 9, 1858.

(Drawn by Pope.)

original appearance, but in the reverse order. To this it may be added that a comet discovered in the Northern Hemisphere usually passes into the Southern Hemisphere after it has made its nearest approach to the Sun, and disappears in that hemisphere. Conversely, a comet discovered in the Southern Hemisphere generally comes North, and disappears in the Northern Hemisphere, but exceptions to this rule are not uncommon.

In size and brilliancy comets exhibit great diversity. It sometimes, but not very often, happens that one appears which is so bright as to be visible when the Sun has not yet sunk below the horizon; but the majority are invisible to the naked eye, and need either a little, or a great deal of, optical assistance. All these latter are "telescopic comets". The appearance of the same comet at different periods of its visibility varies so much that we can never certainly identify a given comet with any other by any mere physical peculiarity of size, shape, or brightness. Identification only becomes possible when its "elements" have been calculated and compared with those of some other comet previously observed. It is now known that "the same comet may, at successive returns to our system, sometimes appear tailed, and sometimes without a tail, according to its position with respect to the Earth and the Sun; and there is reason to believe that comets in general, for some unknown cause, decrease in splendour in each successive revolution".^{*} Halley's Comet, for example, has been thought to have diminished in brilliancy during the many centuries that have elapsed since it was first recognized, judging by a comparison of the descriptions given of it; but doubts have been cast on this supposition by Holetschek, who concludes that for a thousand years from 837 A.D. to 1835 its magnitude has remained fairly constant, between the 3rd and 4th star magnitudes; whilst between 1456 and 1835 there was no great variation in the length of its tail.

Holetschek has carried out some investigations as to the magnitude and brilliancy of comets and their tails from the

^{*} Smyth, *Cycle*, vol. i, p. 235.

earliest times till 1760 which deserve mention here. His object was to arrange in order of magnitude those comets whose orbits have been computed, in much the same way that stars are classified in orders of brightness. In addition, he has attempted to derive the true length of the tail from the records of apparent length, and to examine to what extent the developement of tails depends upon the magnitude of comets and their perihelion distances. Holetschek endeavoured, and with some success, to apply mathematical formulæ to the question of the comparative brilliancy of different comets. His chief conclusions are that some 70 comets lend themselves to a fairly satisfactory determination of magnitude when reduced to the common standard of the Earth's distance from the Sun taken as Unity; and that to about 50 a numerical value can be assigned to the length of their tails. The magnitudes (taken in star magnitudes) range from -1 (the great Comet of 1744) to $9\frac{1}{2}$; but the greater number fall between the magnitudes 4 and 6. So far as regards the tails it would not be safe to draw any more precise conclusion than, that the tail is greater the greater the magnitude, and the closer the approach to the Sun. When the magnitude of a comet (reckoned in star magnitudes) is about the 6th or less, then, as a rule, no tail is developed that can be seen with the naked eye; except under specially advantageous circumstances, as when the comet comes near the Earth. When the magnitude is as great as the 4th, almost all comets when near perihelion have tails visible without optical aid. But when the perihelion distance is large the tail developement is very slight.*

Plate IV represents the comparative diameters of the heads of the well-known comets which are named, as they were measured on particular occasions, compared with the size of the Moon's orbit round the Earth. The woodcut is drawn to scale, but it must not be inferred that the dimensions indicated are in any sense permanent, or very trustworthy.

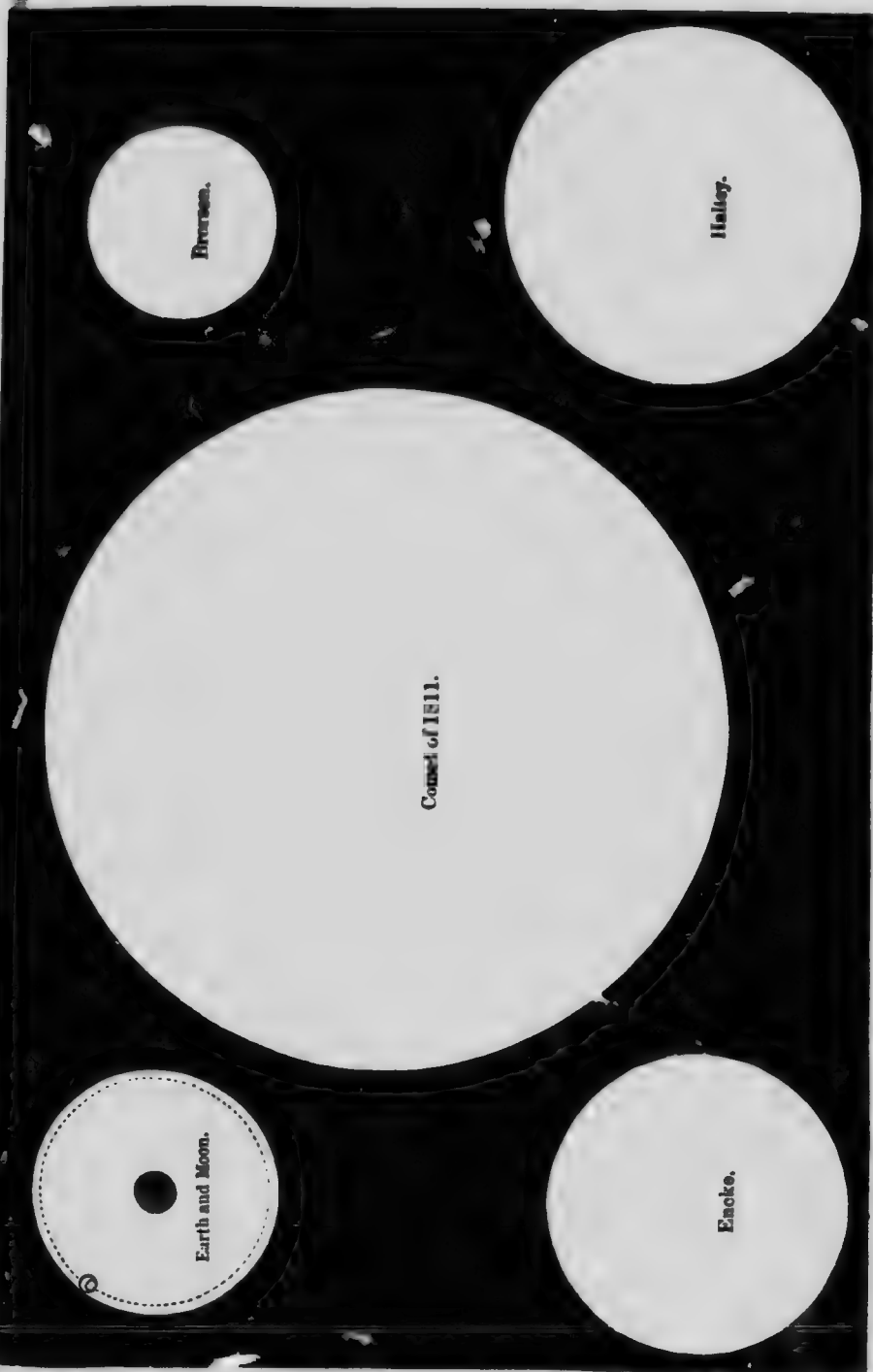
* The ambiguous figure -1 as applied to indicate the magnitude of a star means, speaking roughly, a doubly-bright 1st magnitude star.

e. g. Sirius and a few others.

* *Ast. Nach.*, vol. cxi, no 3359, June 15, 1896; summarised in *Nature*, vol. liii, p. 93 Nov. 28, 1895.

Fig. 6.

Plate IV.



COMPARATIVE SIZES OF THE EARTH, THE MOON'S ORBIT AND CERTAIN COMETS, NAMED.



Aug. 7.



Aug. 18.



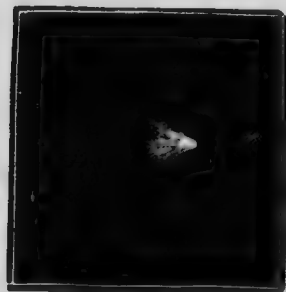
Aug. 18.



Aug. 19.



Aug. 22.



Aug. 29.

THE COMET OF 1862 (iii.).
(Drawn by Challis.)

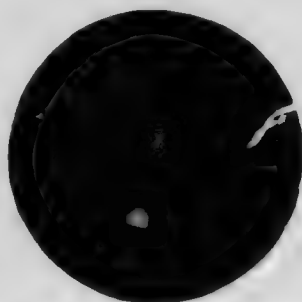
The dimensions may be taken as typical of those of many other comets.

Few things are more remarkable to witness, and more paradoxical to explain, than the changes of bulk which the head of a comet generally undergoes in approaching to, or receding from, the Sun. One might expect, reasoning from terrestrial analogy, that as a comet approaches the Sun the increased heat to which it is submitted would expand its head, whereas the effect observed is the contrary: it grows smaller as it grows hotter. And when receding from the Sun the observed changes are of a converse character; the comet's head seems to expand as it gets farther away and grows cooler. No satisfactory explanation of this anomaly has been given unless it is permissible to accept Sir J. Herschel's idea that the change of bulk is due to some part of the cometary matter remote from the nucleus being evaporated, as it were, under the influence of the Sun's heat, just as a morning mist is evaporated and disappears as the Sun rises in the heavens and its radiant heat becomes more potent.

History informs us that some comets have shone with such splendour as to have been distinctly seen in the day-time. The comets of B.C. 43, A.D. 575 (?), 1106, 1402 (i.), 1402 (ii.), 1472, 1532, 1577, 1618 (ii.), 1744, 1843 (i.), 1847 (i.), 1853 (iii.), 1861 (ii.), 1882 (i.), 1910 (i.), are the principal ones which have been thus observed. Perhaps we might assume that about 4 or 5 comets are so visible in every century. The Comet of 1853 (iii.) was seen on June 10 at Olmütz only 12° distant from the Sun, and again, after perihelion, on Sept. 2, 3, and 4 at noon.

What is the colour of a comet? Have comets ever any colour? From my own observations, extending over many

Fig. 13.



THE COMET OF 1847 (i.), VISIBLE
AT NOON ON MARCH 30.
(Hind.)

years (and I suppose I have telescopically examined more comets than most people), I should not have hesitated to answer these questions in the negative, and have said that all comets exhibit a more or less silvery-grey hue. On the other hand, however, there is a certain amount of evidence available which conflicts with this statement. Passing over what I cannot but consider the sensational assertions of many ancient and mediæval writers of comets appearing of the colour of blood, or fiery red, and so on, we do find in the writings of modern astronomers sufficient evidence to show that such tinges as "yellowish", or "yellow", or "ruddy", are not unprecedented both as regards nuclei and tails. The Comet of 1769, the great Comet of 1811, the great Comet of 1843, Donati's Comet of 1858, Coggia's Comet of 1874, and Fabry's Comet of 1886 (i),^b are cases in point. To this it must be added that in a few rare cases mention is made of "bluish-green" as a tinge which has been noticed. After all said and done, however, I find that in looking into the published accounts of many comets by many observers in different parts of the world, there is a decided preponderance of testimony in favour of "white" or "silvery-grey", or something of that sort, as being the ordinary hue of most comets.

^b "Ruddy brown" is the expression used in this case. *Month. Not. R.A.S.*, vol. .vi, p. 436. June 1886.

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Fig. 14.

Plate VI.



EDMUND HALLEY.

PART II.

HALLEY'S COMET.

Halley's Comet by far the most interesting of the Periodic Comets.—Sir I. Newton and the Comet of 1680.—This Comet the first to which the theory of Gravitation was applied.—The Comet of 1682.—Description of it by various observers.—Luminous Sector seen by Hevelius.—Halley's application to it, and the Comets of 1531 and 1607, of Newton's mathematical researches.—He finds the elements of the three very similar, and suspects the three comets are really one.—With a probable period of 75 years.—Suspects the disturbing influence of planets on Comets.—Of Jupiter's influence especially.—Halley's final conclusion that the Comet would reappear in 1758.—Preparations by Clairaut and Lalande to receive it.—The Comet found by an amateur named Palitzsch near Dresden.—Some account of this man.—The Comet generally observed in Europe.—Trick played by Delisle on Messier.—Return of the Comet in 1835.—Great preparations by Mathematicians to receive it.—These specially took into account planetary perturbations.—Predicted date of perihelion passage.—The Comet discovered by telescopes as expected.—Some particulars of the observations.—The past history of Halley's Comet traced back through many centuries.—Researches of Hind.—Confirmed in the main by Crommelin and Cunnell.—Some quotations from old Chroniclers.—Observations by the Chinese of great value.—Halley's Comet in 1066.—Figured in the Bayeux Tapestry.—The Comet's various returns ascertained with certainty backwards to B. C. 240.

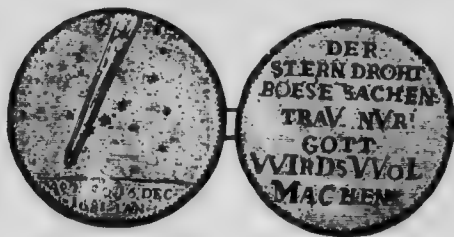
THE comet known as Halley's may be regarded as by far the most interesting of all the comets recorded in history; and this, whether looked at from the standpoint of the historian or of the astronomer; and having regard to the position which it has occupied during many centuries in the public mind, and is likely also to occupy during the present year, it will be worth while to review its career in some detail.

A few years after the advent of the celebrated Comet of 1680 Sir I. Newton published his epoch-making *Principia*, in which he first promulgated the Theory of Gravitation, and applied it to the orbit of that comet. He explained the

Halley's Comet.

method of determining by geometrical construction the visible portion of the path of the comet, and invited astronomers to apply these principles to the comets on record, or some of them. He considered that it was very probable that some comets might move in elongated ellipses which near perihelion would scarcely be distinguishable from parabolas; and he even thought that the recent Comet of 1680^a might be moving in an ellipse the circuit of which would occupy about 575 years.

Fig. 15.



MEDAL STRUCK IN GERMANY TO ALLAY THE TERROR CAUSED BY THE COMET OF 1680.

"The star threatens evil things: Only Trust!
God will make things turn to good."

Halley (to whose exertions the publication of the *Principia* was in great measure due, for he bore the labour and expense of its publication) also took this view. Although we now know that the period of that comet is measured by thousands of years Halley's investigations were not without good fruit,

^a It should perhaps be mentioned, if only in the humble form of a footnote, that this Comet of 1680 gave rise to a special sensation some years after its appearance. A clergyman named Whiston, best known to fame as the author of a standard edition of the works of the Jewish historian Josephus, published in 1696 *A New Theory of the Earth*, in which he sought to explain by the supposed agency of a comet the geological records of the Book of Genesis. At first he based his theory upon nothing except his own imagination, but when he found that

Halley had (erroneously) ascribed to the Comet of 1680 a periodic time of 575 years, Whiston, working backwards the materials of history and fable within his reach, ascribed the Noachian Deluge to one of the regular visits of this comet, and added that it would be by a future visit of the same comet that the prophecies of Holy Scripture as to the destruction of the World would be made good. I think this is sufficient to indicate the value of the Rev. William Whiston's labours in the field of comets.

for they may be said to have drawn him into a systematic study of cometary orbits which ended, as we shall soon see, in a famous and remarkable prediction. He undertook to investigate the movements of a large number of the comets previously recorded, with the view of ascertaining whether any, and if so which, of them had appeared to follow the same path. Careful investigation soon showed that the orbits of the Comets of 1531 and 1607 were similar to each other, and similar in fact to that of the Comet of 1682 seen by himself.

On Aug. 15, 1682, Flamsteed's assistant at the Royal Observatory, Greenwich, discovered a comet. A few days later the diameter of the head was about $2'$ of arc, and it had a tail 5° long. On Aug. 21 the tail had become 10° long. Flamsteed's observations seem not to have extended beyond Sept. 9, when the head had become enfeebled and was scarcely visible in the twilight. Halley himself, however, saw it a day later. Picard at Paris found the comet on Aug. 26, the head shining as a star of mag. 2. On Aug. 29 the tail was curved, the concavity being on the E. side. On Sept. 11 the head was so confused that it was only with difficulty that a luminous point could be perceived. Picard's last observation was on Sept. 12. Hevelius at Dantzic says that the comet was bright at the end of Aug. and could be seen all night with a tail from 12° to 16° long. In large telescopes a nucleus of an oval or gibbous form was constantly noticed. It was also remarked that on many occasions the direction of the tail was not exactly from the Sun, as P. Apian's observations of earlier comets suggested. The most remarkable of the matters mentioned by Hevelius was the existence of a luminous ray, or sector, thrown out from the nucleus into the tail. He has left behind a picture of this which is reproduced in the woodcut on p. 24 (Fig. 16).

This ray was first noted about Sept. 8, and even making every allowance for the vagaries of the astronomical artists of the 17th century it is impossible to doubt that some sort of ray of light was thrown out from the head of the comet, and we shall presently see that the same thing happened in 1835.

The Comet of 1682 seems to have been very generally observed by all the principal astronomers of the time, and amongst those who have left behind them observations we find the familiar names of Kirch of Leipzig, and Montanari of Padua: and the less familiar names of Zimmermann of Nuremberg and Baërt of Toulon.

Halley, making use of Flamsteed's observations, calculated parabolic elements of the comet in accordance with the rules laid down by Newton: and having also determined by the same methods the orbits of the Comets of 1531 and 1607 he was immediately struck by their similarity, and suspected from "the like situation of their planes and perihelions that the comets which appeared in the years 1531, 1607, and 1682

Fig. 16.



HALLEY'S COMET, SEPT. 8, 1682 (N.W.), SHOWING LUMINOUS SECTOR.
(Drawn by Hevelius.^b)

were one and the same comet that had made three revolutions in its elliptical orbit". This supposition implied that the comet's period was somewhere about $75\frac{1}{2}$ years. There were nevertheless 2 circumstances which might be supposed to offer some difficulty, inasmuch as it appeared that the intervals between the successive returns were not precisely equal; and that the inclination of the orbit was not exactly the same in each case. Halley, however, "with a degree of sagacity which, considering the state of knowledge at the time, cannot fail to excite unqualified admiration, observed that it was natural to suppose that the same causes which disturbed the planetary motions would likewise act on comets"; in other words, that the attraction of the planets might be expected to

^b *Annus climactericus*, p. 139.

exercise some disturbing influence on the motions of comets. The discrepancies already pointed out in the orbits of the 3 comets just mentioned made Halley hesitate for some time as to their identity, and in his memoir on comets published in 1705^c he only, as it were, hinted his suspicions. Eventually, however, he became much more confident. This appears to have been the result of his investigations as to the probable influence of the Planet Jupiter. He found that between 1607 and 1682 the comet had passed so near Jupiter that its velocity in its orbit must have been considerably augmented, and its period, consequently, shortened; he was therefore induced to *predict* its return about the end of 1758 or the beginning of 1759. Finally, when he had matured his labours, he thus plaintively wrote on the subject:—"Wherefore if it should return according to our prediction about the year 1758 impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman." On this Hind judiciously remarked as follows:—"Nor has posterity attempted to deprive him of the honours which were his due; his discovery forms an epoch, and an important one, in the history of Astronomy. His calculations must have been laborious in the extreme. He assures us himself they were 'prodigiously' long and troublesome; but the zeal which induced such an amount of exertion was well rewarded by the final result."^d

Halley's first formal announcement of his expectations concerning his comet appears to have been in the paper presented to the Royal Society, in which the following passage (in Latin) occurs:—"Now many things lead me to believe that the Comet of the year 1531, observed by Apian, is the same as that which, in the year 1607, was described by Kepler and Longomontanus, and which I saw and observed

^c *Phil. Trans.*, vol. xxiv, pp. 1882-99, 1704-5. The memoir is entitled *Astronomiæ Cometice Synopsis*. It was translated from Latin into English first of all in John Harris's *Lexicon Technicum*, vol. ii, London, 1710, and

afterwards it was not republished but a new version was prepared, in D. Gregory's *Elements of Physical and Geometrical Astronomy*, 2 vols. London, 1726.

^d Hind, *The Comets*, p. 38.

myself, at its return in 1682. All the elements agree, except that there is an inequality in the times of revolution: but this is not so great that it cannot be attributed to physical causes. For example, the motion of Saturn is so disturbed by the other planets, and especially by Jupiter, that his periodic time is uncertain, to the extent of several days. How much more liable to such perturbations is a comet which recedes to a distance nearly 4 times greater than Saturn, and a slight increase in whose velocity could change its orbit from an ellipse to a parabola? The identity of these comets is confirmed by the fact that in the summer of the year 1456 a comet was seen, which passed in a retrograde direction between the Earth and the Sun, in nearly the same manner; and although it was not observed astronomically, yet, from its period and path, I infer that it was the same comet as that of the years 1531, 1607, and 1682. I may, therefore, with confidence predict its return in the year 1758. If this prediction be fulfilled, there is no reason to doubt that the other comets will return."

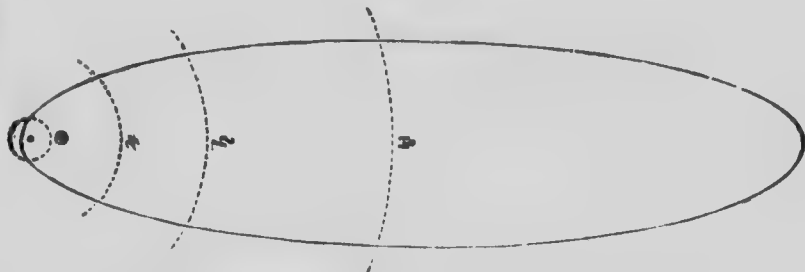
Halley died in 1742 and was buried in the Churchyard of St. Margaret's, Lee, not far from Greenwich, and it has lately (1909) been announced that the Admiralty have decided to repair his tomb at the public expense, no descendants of his being known. The broken and defaced original top slab with an inscription was removed to the Greenwich Observatory in 1854 and put up in a conspicuous position there: and a new one with an exact copy of the original inscription was put in its place in the Churchyard.

The matter is thus alluded to by Sir G. B. Airy in his *Report to the Board of Visitors of the Greenwich Observatory* in June 1855:—

"The Tablet upon Halley's Tomb in Lee Churchyard had apparently received no repair since it was first erected. It had sustained injury, probably from the sinking of the ground, and the unequal dropping of the sides of the tomb; probably also from the strains to which it was exposed when it was taken down for the interment of my predecessor, Mr. Pond, in the same grave. On the last occasion of clearing off the

moss from the inscription, I found the stone so much injured, that mere repair appeared hopeless. On my representing this circumstance to the Board of Admiralty, and representing also the public character of the tomb (the inscription is in Latin, and is such as belongs properly to a national monument), their Lordships immediately supplied the necessary funds for its restoration. In order to effect this, I commenced by taking a 'rubbing' of the inscription, as a guide to be strictly followed by the masons in cutting the new stone; and the new engraving, in regard both to the excellencies of the inscription applying to Dr. Halley himself, and the faults of those applying to his descendants, is a rigorous copy of the old one."

Fig. 17.



PLAN OF THE ORBIT OF HALLEY'S COMET COMPARED WITH THE ORBITS OF CERTAIN PLANETS.

As years rolled on and 1758 began to draw near astronomers naturally recalled Halley's prediction, and thought it worth while to rely upon it in making preparations to receive the comet. The French astronomer Clairaut was the man who took the matter most seriously in hand, the important question being to ascertain the extent of the perturbations of the comet's orbit likely to be brought about by the influence of Jupiter and Saturn. The history of the steps taken cannot be better described than in the words of Hind:—"Having devised a method which appeared to possess all needful accuracy, he commenced, in conjunction with the celebrated Lalande and a lady, Madame Lepaute, the immense mass of calculations requisite for the complete attainment of his

object. It was necessary to compute the distances of the comet from the disturbing planets, Jupiter and Saturn, not only from 1682, when it was last observed, but for the previous revolution, or for a space of more than 150 years. This of itself was a most laborious business; but the succeeding part of the work, where the disturbing force of each planet was required for this long period, involved much greater and more intricate calculations. Lalande minutely describes the plan adopted: for 6 months they computed from morning to night with but little intermission, even, as he states, at meals: and he mentions, as one result of this assiduous attention to the work, that he contracted an illness which remained upon him during the rest of his life. Madame Lepaute's assistance is said to have been so important, that without it they would hardly have completed the investigation before the comet reappeared. However, by dint of these extraordinary exertions, the calculations were brought to a close."

On Nov. 14, 1758, Clairaut announced in a paper addressed to the Academy of Sciences at Paris, that by the influence of Jupiter the comet would be retarded 518 days, and that to this must be added 100 days due to Saturn, so that the total retardation would be 618 days, or about 20 months. On this basis he predicted April 13, 1759, as the date of the coming perihelion passage. He did this, however, with a slight reservation, because, having neglected some small quantities in the calculations, he thought that the date named might be wrong by a month either way. When Clairaut's conclusions became generally known the astronomers of Europe were soon on the *qui vive*, and several of them carried out a prolonged watch of the heavens, which in Messier's case extended over the whole of the year 1758. It was not destined, however, that a professional astronomer should be the first to detect the comet on its anticipated return; that honour was reserved for an amateur student of Nature, said to have been a farmer by occupation, named Palitzsch, living at Prohlis, near Dresden, who saw it on the night of Christmas Day, 1758, with a telescope of 8 ft. focus. Some curious mis-statements respecting this man have been lately circulated,

and perhaps even to this day may be considered as still in circulation. Baron De Zach, who was personally acquainted with the man, has left on record some interesting particulars relating to him. Farmer though he was, he was a diligent student of Astronomy; was possessed of a strong sight: and was in the habit of scrutinising the heavens with the naked eye, which fact may perhaps have given rise to the statement that he found Halley's Comet with the naked eye at a time when the professional astronomers were vainly searching for it with their telescopes. The first man of note to find the comet appears to have been Messier, who caught it in bad weather on Jan. 21, and observed it regularly for 3 weeks. It seems that Delisle, then Director of the Observatory of Paris, would not allow Messier (who was his assistant) to disclose the fact of his discovery, and he remained the only professed astronomer who saw the comet before it became lost in the Sun's rays at its perihelion passage. Let us hope that Hind's remark on this incident will remain true:—"Such a discreditable and selfish concealment of an interesting discovery is not likely to sully again the annals of Astronomy." This strange conduct of Delisle's carried its own punishment, for when Messier's observations were afterwards published some members of the French Academy treated them as forgeries; but there appears to have been no sufficient ground for this imputation, and it was eventually withdrawn. It remains to be added that the comet passed its perihelion on March 12, 1759—just within the limits assigned by Clairaut. After that, it was seen throughout Europe during April and May, although to the best advantage only in the Southern Hemisphere. On May 5, it had a tail 47° long.

Previous to the return of the comet in 1835, numerous preparations were made to receive it.

The great progress which had been made since 1759 in telescopes and methods of observation, especially under the inspiration of the two Herschels, Sir William and Sir John; and also in mathematics applied to celestial motions by men like Laplace, Lalande, La Grange, and other eminent foreigners, rendered the study of the movements of this comet, both

visually when the time came to see it, and mathematical before that time, a problem of great interest. As long before the expected return of the comet as 1817 the Academy of Sciences at Turin offered a prize, open to astronomers of all nations, for an Essay on the perturbations undergone by the comet since 1759. Baron Damoiseau of Paris gained the prize, and his Essay was published in 1820 in the *Memoirs of the Turin Academy*, vol. xxiv. The following outline of the researches of Damoiseau and others is epitomised from Hind's statement of them.

After calculating the effects of the attraction of the large planets he fixed Nov. 4, 1835, at 8 p.m., Paris M.T., as the moment of the comet's perihelion passage. After Damoiseau another Frenchman, Count de Pontécoulant, took up the matter, more or less on the same lines as Damoiseau, with the result that his date for the perihelion was rather more than a week later than Damoiseau's, or to be exact, he fixed the perihelion for Nov. 12, at 17^h, Paris M.T. The investigations both of Damoiseau and Pontécoulant were in a sense defective because both of them had omitted to take account of certain of the planets whose influence counted for something. Accordingly a German computer, Rosenberger of Halle, started on a new and independent investigation. Damoiseau and Pontécoulant had neither of them attached sufficient importance to the actual ellipse described by the comet in 1759. As 1759 was the starting-point from which to determine the probabilities of 1835, it was important to obtain the most accurate knowledge possible of the condition of things in 1759. Rosenberger thought that he ought to go much further back than Damoiseau had done, and that it would be impossible to make a trustworthy prediction for 1835 unless he began as far back as 1682, and computed the perturbations between 1682 and 1759, and so led up to 1835.

In performing his task Rosenberger took account not only of the influence of the great planets Jupiter, Saturn, and Uranus, but also of the smaller influence exerted by Venus, the Earth, and Mars, with some allowance also for Encke's supposed Resisting Medium as affecting his (Encke's) Comet.

Omitting in the first instance any allowance for a Resisting Medium Rosenberg fixed Nov. 11, at 0^h Paris M.T., for the comet's perihelion passage. If an allowance supposed to be appropriate were made for a Resisting Medium the perihelion would fall about a week earlier or on Nov. 3 at 19^h Paris M.T. The actual effects on the comet's motion ascribed to the smaller planets were as follows:—the Earth 15½ days, Venus about 5½ days, and Mercury and Mars together nearly 1 day. By these periods of time (namely, about 22 days) added together, Rosenberg considered that the comet's return would be hastened. "Professor Rosenberg's investigation is remarkable for its extraordinary completeness, for the pains taken to include every possible source of perturbation, without regard to the numerical labour, and for the masterly manner in which the whole of the vast work was conducted."

Rosenberger, however, had a competitor in his own country. Lehmann thought there was room for another discussion of the elements and disturbances of the orbit of Halley's Comet, and though his labours were not in some respects as meritorious as Rosenberg's they have a merit of their own, inasmuch that Lehmann took the year 1607 as his starting-point. On this basis he fixed Nov. 26 for the perihelion passage, which was a date a fortnight later than Pontécoulant's and 3 weeks later than Damoiseau's.*

As early as Dec. 1834, astronomers began to direct their telescopes to that part of the heavens where it was supposed that the comet would be first seen. Olbers had thrown out suggestions that it might be possible to find the comet between Dec. 1834 and April 1835, notwithstanding that the perihelion passage would not take place till many months later. Olbers's suggestion was largely acted upon, for it applied to the constellations Auriga and Taurus which were very favourably placed for observation in Northern and Central Europe, while

* The distracting effect of planetary perturbations on the movements of comets is shown by the fact that whereas the interval between the perihelion passages of Halley's Comet in 1835 and 1910 is to be set down

at 74 years 5½ months (the shortest on record), in 1222 and 1301 it was 79 years 2 months (the longest on record, the next longest having been 1066 and 1145).

Sir John Herschel at the Cape employed his great reflector also in sweeping for the anxiously expected body. But all these early efforts were wasted.

It was not until the morning of Aug. 6 that the first view of the comet was obtained, and the fortunate man was Dumouchel, director of the Collegio Romano Observatory at Rome, using a powerful telescope in a splendid climate. The comet was close to the computed place which was near ζ Tauri. It was a faint, misty object, discernible with difficulty, and moonlight and unfavourable weather during the next following days delayed the comet's discovery elsewhere. However, on Aug. 21 W. Struve found it with the great telescope at Dorpat, and during the following week it was seen at all the principal English and Continental observatories. The Dorpat observations showed that Rosenberger's predicted place was only $7'$ of arc wrong in R. A. and $17'$ in Declination. The effect of this error was to retard the perihelion passage till Nov. 16, or 5 days later than the epoch fixed upon by Rosenberger. During the first 3 weeks of Sept. the comet's brightness gradually increased, and on the 23rd it was seen with the naked eye by Struve, and on the following day with the naked eye by Kaiser at Leyden, though it was not sufficiently bright to attract general notice till the end of the month. A tail was first seen on Sept. 24, and during October the comet was more or less conspicuous, but observers differed very much in their estimates of the maximum length of the tail. The average of the estimates would seem to have been from 20° to 25° , though one observer did put it at 30° . The comet was lost to view about the time of perihelion passage, disappearing below the S. W. horizon, and having, according to most accounts, lost its tail before the comet itself was lost to view. After the perihelion passage the comet was again observed at some of the southern observatories of Europe and at the Cape of Good Hope from Dec. 30 to the middle of May 1836.

Smyth's observations deserve to be quoted. Under the dates of Oct. 10 and 11 he wrote:—

"Oct. 10. The Comet in this evening's examination presented an extraordinary phenomenon. The brush, fan, or gleam of light, before

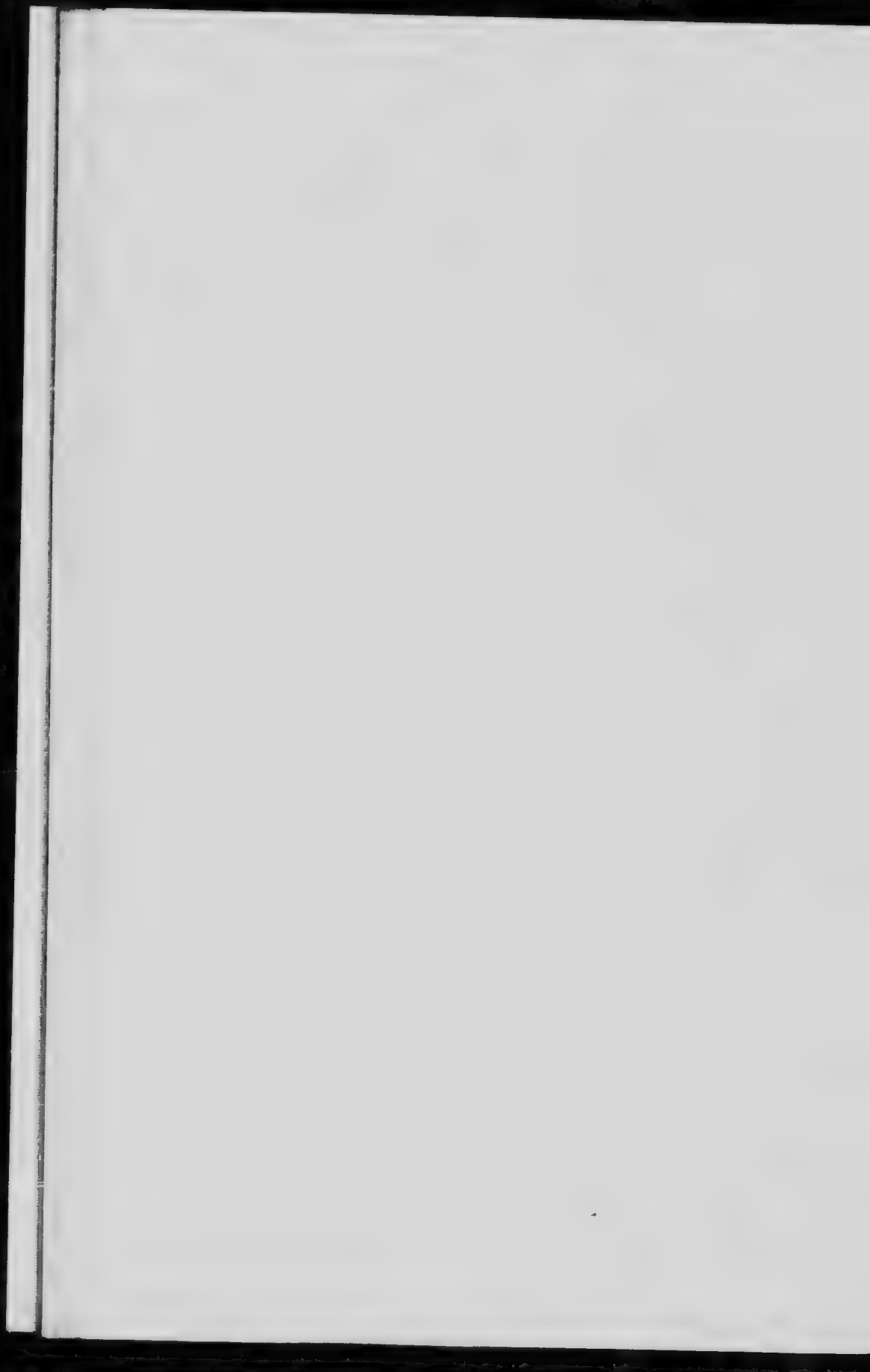
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HALLEY'S COMET, 1835 6.
(Drawn by C. P. Smyth.)



mentioned, was clearly perceptible issuing from the nucleus, which was now about 17" in diameter and shooting into the coma; the glances at times, being very strong, and of a different aspect from the other parts of the luminosity. On viewing this appearance it was impossible not to recall the strange drawing of the 'luminous sector' which is given by Hevelius in his *Annus Climactericus* as the representation of Halley's Comet in 1682 and which had been considered as a distortion. [See Fig. 16, ante.]

"Oct. 11. . . . The tail was increasing in length and brightness, and, what was most remarkable, in the opposite direction to it there proceeded from the coma across the nucleus a luminous band or lucid sector more than 60" or 70" in length and about 25" broad, with 2 obtuse-angled rays, the nucleus being its central point. The light of this singular object was more brilliant than the other parts of the nebulosity, and considerably more so than the tail; it was therefore amazingly distinct. On applying as much magnifying power as it would bear, the nucleus appeared to be rather gibbous than perfectly round; but with the strange sector impinging it was a question of difficulty."

The observations made at the Cape of Good Hope by Maclear disclosed a succession of phenomena somewhat calculated to chill the enthusiasm of any who expected great things of Halley's Comet in 1910. Though the perihelion passage took place on Nov. 15, 1835, Maclear did not begin to see the comet, or at any rate to record what he saw, till Jan. 24, 1836. He says that the alteration of form which had taken place between the beginning of November and this date, during which interval the comet had been lost in the Sun's rays, was "remarkable", and he goes on as follows:—

"Jan. 24. To the naked eye it was as bright as a star of the 2.3 or 3rd magnitude: there was no tail. In the 14-feet reflector, it presented an opaque, circular, planetary disc, tolerably well defined, encompassed by a delicately bright coma or halo, which was likewise circular.

"Crossing the disc in a direction not deviating much from parallelism with the equator, appeared an oblong, elliptical body, distinguished from the rest of the disc by its superior whiteness, and a semblance of greater density. The diameter of the disc measured 2' 11"; of the coma, 8' 12".

"On the 25th, the circularity of the preceding limb of the cometary disc was partially broken, its dimensions were increased, the elongated portion was better marked, and its following end was brighter than the preceding.

"On the 26th, the halo had diminished, and the dimensions of the disc, or body, as it should now be called, were further increased. A spot like a nucleus could be occasionally seen in the brighter end of the oblong portion.

"On the 28th, the halo or coma had vanished. The nucleus was distinct, like a faint small star in the following end of the oblong portion. The dimensions of the body had greatly increased, while the intensity of its light had proportionately diminished. The general outline of the cometary body seemed approximating to a parabolic curve, the preceding end of which

might be represented by conceiving the tail, as seen before the perihelion passage, abruptly separated from the head, leaving a serrated or rugged outline. The oblong portion with the nucleus resembled a small comet inclosed in the body of a larger one.

"On the 30th, the body was rather more elongated. A line drawn transversely through the nucleus measured $11' 42''$, being 5 times the diameter on the 24th; or 29 times the area of a circle of which $2' 11''$ is the diameter. But the visible area of the whole body on the 30th could not be less than 35 times that of the 24th, excluding the halo. The nucleus was nearer to the S. than to the N. side by $32''$.

"Throughout the succeeding three months the coma went on increasing, until the outline finally became so faint as to be lost in the surrounding darkness, leaving a blind, nebulous blotch with a bright centre enveloping the nucleus of variable brightness, depending on moonlight or the state of the atmosphere, and variable distance."

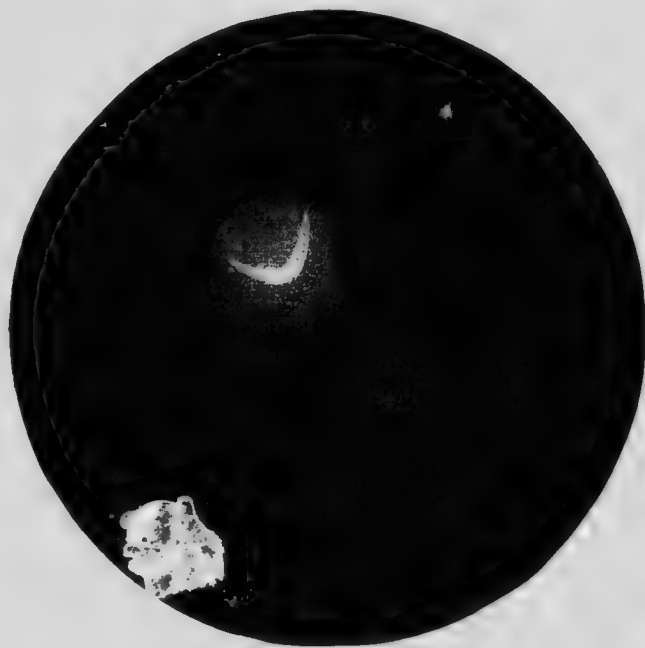
The physical appearance of Halley's Comet at the 1835 apparition seems to have been in many respects very remarkable, and, did the statements made not emanate from some of the most distinguished astronomers of the time, it might be permissible to distrust them. It is impossible, however, to distrust anything stated by such men of skill and high character as Bessel, J. Herschel, W. Struve, and Maclear. Struve compared the appearance of the nucleus about the end of the first week of October to a fan-shaped flame emanating from a bright point; and subsequently to a red-hot coal of oblong form. On Oct. 12 it appeared like the stream of fire which issues from the mouth of a cannon at a discharge and when the sparks are driven backwards by a strong wind. At moments the flame was thought to be in motion, or exhibiting scintillations similar to those of an Aurora Borealis. A second small flame forming a great angle with the principal one was also remarked. On Nov. 5 the nebulosity independently of the flames (two of them being visible) had a remarkable arched form somewhat resembling a "powder horn". These phenomena, under different and varying names, were seen and commented upon by other astronomers, British and foreign. The annexed sketch by Admiral Smyth would seem to represent fairly well all the remarks made by the various astronomers just cited.²

¹ *Mem. R. A. S.*, vol. x, p. 92. 1837.

² Drawings by Bessel will be found in the *Ast. Nach.*, vol. xiii, Nos. 300-2.

It will be interesting to consider what we know of the history of this comet anterior to the apparitions already mentioned. Halley, we have seen, satisfactorily traced back his comet to 1531, but since his time it has been traced very

Fig. 19.



HALLEY'S COMET, 1835, OCT. 11. (Smyth.)

much farther backwards, through a range indeed of some 14 centuries or more, first by the labours of Hind,^h and Laugier,ⁱ and quite recently by those of Cowell and Crommelin^k confirming Hind for the most part, and enlarging his results.

Feb. 10, 1836. Reference may also be made to the *Memoirs of the Astronomical Society*, vol. x (drawings by C. P. Smyth); Sir J. Herschel's *Results of Astronomical Observations at the Cape of Good Hope*; and Struve's *Beobachtungen des Halleyschen Kometen*.

^h *The Comets*, p. 50 et seq.

ⁱ *Comptes Rendus*, vol. xxiii, p. 183. 1846.

^k *Month. Not. R.A.S.*, vol. lxviii. 1908. (Five separate papers, at pp. 111, 173, 375, 510, 665.)

The years in which identification may be regarded as more or less certain are the following¹:—

Year.	Interval in Years.	Year.	Interval in Years.
B. C. 11.8	76.9	989.7	
A. D. 66.1	75.1	1066.2	76.3
141.2	77.2	1145.3	79.0
218.2	77.0	1222.7	77.4
295.2	78.6	1301.8	78.9
373.8	77.6	1378.8	77.0
451.5	79.3	1456.4	77.6
530.8	76.5	1531.6	75.2
607.3	77.5	1607.8	76.1
684.8	75.6	1682.7	74.9
760.4	76.8	1759.2	76.5
837.2	75.0	1835.9	76.7
912.6	77.1	1910.1	74.5

Cowell and Crommelin have found themselves justified in adding to this table, backwards, the years B.C. 87 (August or September) and 240 (May); with no identification possible for the intermediate return in June, 163 B.C., though comets are vaguely mentioned in the years 166 and 165.

We owe the observations which have made these identifications possible mainly to Chinese records, supplemented, more or less, by European monastic chroniclers of various sorts and kinds, and by a few private authors. It would be tedious to transcribe any of the originals of these, even in an abridged form; indeed, in point of fact their language is already generally

¹ This table is from Hind, but altered where necessary to embrace the researches of Cowell and Crommelin. Hind tried to identify the comet by noting the observed paths of certain comets; and the descriptions at his command were often very vague and uncertain; but Cowell and Crommelin's results were based on accurate calculations of the lengths of successive revolutions as

affected by planetary perturbations. On this account they are justified in laying claim to a much higher degree of certainty for their identifications. Some share of credit for these identifications is due to the French astronomer Laugier. (*Comptes Rendus*, vol. xxiii, p. 183. 1846.) Nor should the labours of Pingré and Burckhardt be forgotten, in connexion with this matter.

so curt as to be incapable of abridgement, so a concise digest is all that will be offered to the reader, and this will be often given in the language of Hind^m and chronologically backwards.

Halley surmised that the great Comet of 1456 was identical with his, and Pingré converted Halley's suspicion into a certainty. This comet was described by the Chinese as having had a tail 60° long, and a head which at one time was round, and the size of a bull's eye, the tail being like a peacock's!

At the preceding return of 1378 the comet was observed both in Europe and China; but it does not appear to have been as bright as in 1456.

In 1301 a great comet is mentioned by nearly all the historians of the period. It was seen as far North as Iceland. It exhibited a bright and extensive tail which stretched across a considerable part of the heavens. Hind rejected the European observations of 1301, finding them to be of no good compared with the Chinese observations which proved consistent—a reversal of 20th-century preferences!

The previous apparition was for some time a matter of doubt. Hind treated as Halley's a comet which appeared in July 1223, and was regarded as the precursor of the death of Philip Augustus, King of France. The records are vague and inadequate; and Cowell and Crommelin have given the preference to a comet which was seen in August and September 1222 and which passed its perihelion probably in September. The Waverley Abbey Annalist says that in the months named a fine star of the 1st magnitude, with a large tail, appeared. When first seen it was near the place where the Sun sets in December. The Chinaman Ma-tuoan-lin says that on Sept. 25 it came from η Bootis. The tail was 30 cubits long, and the comet perished in two months. The question of the identification of one of these comets with Halley's is one of the few instances in which Cowell and Crommelin have dissented from Hind's identifications by deciding in favour of the Comet of 1222 in preference to Hind's 1223.

In April and May 1145 the European and Chinese chroniclers record a comet with a tail 10° long, whose course among the

■ *Month. Not. R.A.S.*, vol. x, p. 51. Jan. 1850: *The Comets*, pp. 50-57.

stars from the end of April to the beginning of July is stated by Hind to have been perfectly in accord with the computed path of Halley's Comet, supposing the perihelion passage to have taken place about the 3rd week in April. The Chinese accounts seem to speak of the July Comet as being different from the April and May one, but whether this was so or not cannot be determined with any certainty. Hind seemed to regard the two to be one and the same.

In the April of the year 1066, the year in which the Norman Conquest took place, a remarkable comet attracted the attention of all Europe. In England it was viewed with especial alarm and the success of the Norman invasion and the death of Harold were attributed to the comet's baneful influence. Zonares, the Greek historian, in his account of the reign of the Emperor Constantinus Ducas (whose death occurred in May 1067) describes a comet which was as large as the full moon, and at first was without a tail, on the appearance of which, it (which presumably means the head) diminished in size. This transformation accords with the Chinese accounts, which describe the comet's path among the stars in Chinese fashion with great elaboration. The Chinese say that this object was visible for 67 days, after which "the star, the vapour, and the comet" all disappeared. It seems certain that this was Halley's Comet, and it was immortalised in the famous Bayeux Tapestry, as will be seen from Plate I on page 6 (*ante*).

In 989 a comet was observed in China which is mentioned also by several Anglo-Saxon writers. Burckhardt, the French computer, investigated its orbit and found that the elements bore a considerable resemblance to those of Halley's Comet. The perihelion passage was found to have occurred about Sept. 12.

Halley's Comet should have appeared in 912, passing perihelion in July. There were perhaps 2 comets in this year. Cowell and Crommelin differ from Hind in the identification, Hind being satisfied with the early one visible in May. Cowell and Crommelin demand a later one. The record of one which is dated for some time in the year, beginning in

August, and which therefore may have been visible in the autumn, may or may not be the one wanted.

Halley's Comet should have appeared in 837. A comparison of the European and Chinese accounts, taken literally, imply that there were 2 comets in this year, one in perihelion in February and the other in April. The latter would seem to have been a most imposing object, but in Hind's opinion it could not have been Halley's Comet, and Cowell and Crommelin state definitely that Halley's Comet must have been in perihelion at the end of February or the beginning of March. The Chinese records indeed imply that there was a third or even a fourth comet in that year, in the months of June and September, but this question (which probably involves some misconceptions) does not concern us in discussing Halley's Comet.

A comet appeared in 760, which without any doubt whatever was Halley's. It is recorded in detail both by European and Chinese annalists, and the orbit has been calculated and identified by Laugier. By European writers we are told that a comet like a great beam and very brilliant was observed in the 20th year of an Emperor Constantine, first in the E. and then in the W., for about 30 days. The Chinese gave it a visibility of 2 months. Laugier calculated the perihelion to have occurred on June 11.

In 684 the Chinese record a comet observed in the W. in September and October. Hind pointed out that this statement would accord with the course of Halley's Comet when the perihelion occurs about the middle of October, and, as the epoch for the reappearance of the comet is about what it should be, the identity may be considered assured.

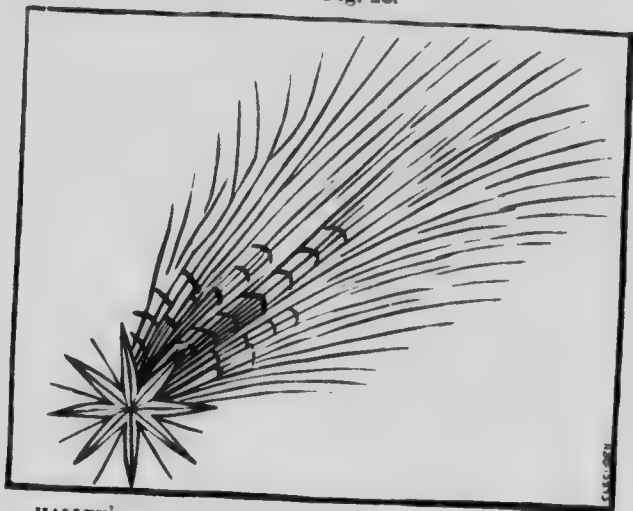
A comet observed by the Chinese in the constellations Auriga, Ursa Major, and Scorpio in 608, was regarded by Hind as probably Halley's, who said that the track assigned would harmonise with a perihelion passage occurring about Nov. 1. Cowell and Crommelin, however, identified the Comet of 607 (i.) as Halley's.

The previous return should have occurred in 530. There was a comet in that year, and none of the few circumstances

connected with it recorded by the European chroniclers a contradictory to the theory which implies that the comet was Halley's. The perihelion passage may be dated for November 1835.

A comet appeared in 451, as to which there is little doubt that it was Halley's, according to the investigations of Laugier. It was seen in Europe about the time of the celebrated battle of Châlons, when the Roman general Aetius defeated Attila.

Fig. 20.



HALLEY'S COMET, 684. (From the Nuremberg Chronicle.)^a

the leader of the Huns, who had been ravaging central Europe. In China the comet was observed from the middle of May till the middle of July, during which period it moved from the Pleiades into Leo and Virgo, a track which agrees with the path which Halley's Comet would have followed if its perihelion passage took place on July 3.

^a This engraving and Plate I suggest that mediæval artists were given to "terminological inexactitudes" like many of their successors. As regards Plate I J. C. Bruce, the editor of *The Bayeux Tapestry elucidated*, says: "This drawing is remarkable as furnishing us with the earliest representation we have of these bodies." It requires a little interpretation. The picture is sup-

posed to represent Harold in a state of dire alarm on his throne, whilst his people are huddled together pointing with their fingers at the fearful portent in the sky, the birds even being upset at the sight. The legend over the picture "Isti mirant stella" records the popular feeling. Underneath we are asked to take notice of the ships of the invader.

In 373 the Chinese annals record a comet in Ophiuchus in October, which Hind thought would fit in with the probable position of Halley's Comet if the perihelion passage took place about the beginning of November. But another Chinese authority records a comet much earlier in the year, namely in March and April, which must have been visible all through the summer if it were the same as the October comet.

In 295 there was a comet observed in China, the identity of which with Halley's Hind thought to be "nearly certain". It seems to have been visible in May after perihelion passage at the commencement of April.

In the year 218 a large comet is recorded both by European and Chinese chroniclers. Dion Cassius describes it as a very fearful star with a tail extending from the W. towards the E. The Chinese catalogue of Ma-tuan-lin gives it a path exactly in agreement with the path which would be followed by Halley's Comet when the perihelion falls about the first week in April. The description given is that it was "pointed and bright".

In 141 the Chinese observed a comet in March and April, "6 or 7 cubits long" and of a bluish-white colour. The elements of a comet following a path such as that described in some detail by the Chinese annalist would not be widely different from those of Halley's Comet; and the comet is the only one recorded about this epoch.

The preceding apparition should have taken place either in the summer of 65 or in the following winter of 65-66. The Chinese record 2 comets: one in July 65 which remained visible for 56 days, and the other in February 66 which remained visible 50 days.

Hind suggested that most likely the last-named was Halley's Comet, if the perihelion passage took place at the end of January, and Cowell and Crommelin have definitely confirmed this. Not improbably this comet was the sword-shaped sign recorded as having hung over the city of Jerusalem before the commencement of the war which terminated in the destruction of the Holy City. Josephus says that several prodigies announced the destruction of

Jerusalem: "Amongst other warnings, a comet, of the kind called Xiphias, because their tails appear to represent the blade of a sword, was seen above the city for the space of a whole year." Josephus rebuked his countrymen for listening to false prophets while so notable a sign was in the heavens.

Dion Cassius mentions a comet which seemed to be suspended over the city of Rome before the death of Agrippa. The date would be B.C. 11. The path of this comet was recorded in great detail by the Chinese, and Hind thought that the records afforded "the most satisfactory proof that they belonged to the Comet of Halley". The 3rd week of October was suggested for the perihelion passage. The comet was lost in the Sun's rays 56 days after its discovery.

Cowell and Crommelin have made systematic efforts to trace Halley's Comet back further, and with some success, and it is not beyond the bounds of possibility that further identification will reward research because the Chinese records go back for six centuries before the Christian era, and besides them there exists a sprinkling of European observations, although all these latter are very much lacking both in precision of language and precision of dates.

The danger of jumping at conclusions in the case of astronomy (as indeed in everything else) is painfully shown by an article in the *Edinburgh Review* of April 1835 (vol. lxvi, p. 91).

The writer, primed with the knowledge that the period of Halley's Comet was then 75 years, and not knowing that it was not always 75 years, looked through a catalogue of previous comets and ticked off the following, separated by intervals of 75 years or multiples thereof, as apparitions of Halley's Comet, namely: 1456, 1380, 1305, 1230, 1005, 930, 550, 399, 323 A.D. and 130 B.C. We now know that every one of these identifications except the first was wrong! The attraction exercised by the planets was ignored by the writer!

The reader will remember that in anticipation of the

^u *Bella Judaeorum*, lib. vi, § 5.

return of Halley's Comet, both in 1759 and in 1835, great preparations were made by astronomers for the comet with the view of its being discovered at as early a date as possible, and of learning beforehand its probable path through the heavens. Somewhat similar preparations but perhaps not so extensive were made by mathematical astronomers for the return of 1910.

Between 1835 and 1910, and in the earlier part of the interval, Halley's Comet underwent great perturbations by Jupiter, which very much augmented the labour of preparing for the 1910 return. However notwithstanding this, Pontécoulant, 46 years before 1910, assigned a date for the perihelion passage not very far wrong, and Cowell and Crommelin's final prediction issued in January, 1909, proved to be correct within 3 or 4 days. This result was appreciably better than the predictions made before the 1835 return.

Considering that Halley's Comet may be regarded as the largest and best known of the recognized periodical comets it is no wonder that its return in the spring of 1910 was not only a matter of keen competition between the astronomers manag- ing telescopes large enough to grapple with its early discovery, but also created a great amount of interest, not to say excitement, amongst non-professional people in all parts of the world. The facilities afforded by the camera for picking up dim celestial objects were made the most of, and so it came about that as early as September 11, 1909, a plate taken by Wolf at Heidelberg was recognized for a certainty as recording the comet, though an object seen on a plate taken by the same observer at the same place on August 28 was suspected. Even these two dates do not mark the earliest visibility of the comet, for a plate taken by Keeling at Helwân in Egypt on August 24 contained an image of it, though some months elapsed ere the fact of the comet being on the plate was ascertained. Subsequent to Wolf's definitive announcement immediately after September 11 that he had secured the comet, it was found that the comet was shown on a plate taken at Greenwich on September 9. This jumble of dates will convey to the reader some notion of the competition

which there was as to who should have the credit of having obtained the first picture of the long looked-for visitor. Wolstenholme's announcement, published as a certainty, gave a great impulse to the search for the comet. Before passing on it may be worth while to remark that as far back as the beginning of 1908 photographic efforts were made at both Greenwich and Heidelberg to find the comet, whilst in December, 1908, a search was commenced by Dr. O. J. Lee at the Yerkes Observatory, Chicago. Lee concluded from his failure to detect any trace of the comet that at the time in question it must have been less bright than a 17th magnitude star.

At Mount Hamilton the comet was photographed on September 12, but the first visual observation of it there in the 36-inch reflector dates only from October 16. During November and December the comet was observed in a number of places and in instruments of various dimensions, but the observations cannot be described as particularly satisfactory nor the observations themselves as particularly consistent. The fact seems to be that the comet underwent irregular fluctuations in brilliancy which did not depend upon the actual changes which took place in its distance from time to time from the earth.

On the whole the best early observations which have been published were those made by the Rev. T. E. R. Phillips at Ashstead in Surrey. Between November 22 and December 29 he saw the comet on ten nights and thus records his impressions up to December 29, 1909:—

"It has never regained the brightness of November 22, when it was quite unexpectedly about Magnitude 10, but it exhibited some fluctuations in light. After being very faint at the end of November (nearly as low as Magnitude 12) it revived somewhat in the early part of December, but on December 6, under excellent observing conditions, it was again as faint as Magnitude 11.5 or 12. On December 8 it could just be glimpsed occasionally with 3½ inches eccentric stop, and its mag. was probably about 11. It was not seen again owing to bad weather till 18th, when it was surprisingly faint considering its greater proximity, probably below Mag. 12, and on 20th it was probably below Magnitude 12.5. On 25th the moon was nearly full, and the comet invisible, but it was again observed on 28th. On that occasion it appeared about as difficult as when it was first seen at Ashstead on Nov. 16. The estimated magnitude was 13, but perhaps sufficient allowance was not made for the

strong moonlight. The comet has usually exhibited the appearance of a small stellar nucleus surrounded by a nebulous haze "p

During January, February, and March, and till nearly the end of April observations of the comet were carried on only to a limited extent owing to its position relatively to the Earth and the Sun and such observations as there were do not seem to call for any notice here. After passing its perihelion on April 19 the comet became a morning star and was picked up by a limited number of observers in the early morning hours averaging say 4 a.m., but it was never far from the Sun, so that the approach of sunrise coupled with a full Moon on April 24 made it wellnigh impossible for the comet to present any striking appearance. This condition of things did not arise until after the comet had crossed the Sun on May 18, and had become an evening star. Then again twilight, and a Moon new on May 8, once more interfered with a satisfactory view of the comet, so that when it first became visible in the evening twilight, after being actually nearest to the Earth about May 18, it failed to show itself as the magnificent object which had been hoped for, though it was well understood, or at least assumed, that under no circumstances could it be expected that it would show up as it had done in many bygone centuries.

Spectroscopic observations date back to Oct. 22, when a faint continuous spectrum was photographed at the Lick Observatory.

p Journ. B.A.A., vol. xx, p. 155. Dec. 1909.

EPHEMERIS OF HALLEY'S COMET.

MAY 26—JULY 25, 1910.

Date.	Right Ascension.	Declination.	Distance from Earth in radii of Earth's orbit.
1910	h. m. s.	° ' "	
May 26	9 31 28	2 53	0.36
" 30	9 56 16	1 0 N.	0.51
June 3	10 9 56	0 4 S.	0.66
" 7	10 19 48	0 43	0.81
" 11	10 27 28	1 15	0.97
" 15	10 31 56	1 42	1.12
" 19	10 36 24	2 3	1.28
" 23	10 40 16	2 24	1.40
" 27	10 44 0	2 45	1.54
July 1	10 47 28	3 6	1.70
" 5	10 50 36	3 24	1.86
" 9	10 53 40	3 41	1.95
" 13	10 56 40	4 1	2.07
" 17	10 59 40	4 20	2.19
" 21	11 2 36	4 38	2.31
" 25	11 5 28	4 56 S.	2.43

After quitting Pisces, about May 14, its path will be through Aries, Taurus, Gemini, the head of Orion, Canis Minor, Hydra, Sextans, the feet of Leo, and Virgo, where it will probably be last seen: but the long days and short nights, and full Moon on May 22, with no true night at all during many weeks, will seriously interfere with observations of the comet. During its post-perihelion career the comet will pass not far from a considerable number of bright stars which may be a little help to those who, living in the Southern hemisphere, at the Cape, or in Australia, or New Zealand, may desire to follow the comet as long as possible. Aldebaran (α Tauri, mag. 1.0), Betelgeuze (α Orionis, mag. 1.0), γ Geminorum (2.0), and Procyon (α Canis Minoris, mag. 0.5) are some of the stars to which the foregoing remark applies.

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